APPLICATION NO. 10/806,016

INVENTION: Multi-scale code division frequency/wavelet multiple
access

INVENTORS: Urbain Alfred von der Embse

Currently amended CLAIMS

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WHAT IS CLAIMED IS;

Claim 1. (currently amended) A ~~means~~ method for ~~the~~ ~~design~~implementation of new multi-resolution complex Wavelet

10   waveforms —in the Fourier domain, and for ~~the~~ ~~design~~implementation —of new orthogonal Wavelet division multiple access OWDMA filter banks, ~~with these Wavelets with properties which~~ said method comprising:

        using ~~provide a means for the~~ complex extensions of the

15   Wavelet concept to the Fourier frequency domain with ~~the~~ addition of frequency translation as a Wavelet parameter to ~~the~~ existing scale (dilation) and translation (shift) parameters for Wavelets~~.~~;

        using ~~provide a means for the~~ a single multi-resolution

20   complex Wavelet ~~design~~ implementation for ~~all of the~~ Wavelets at multiple scales, frequencies, and translations;

        using ~~a~~~~provide a means for~~ multi-resolution complex Wavelet ~~design methodologies~~implementation —~~that~~to circumvent ~~the~~a need to apply ~~the~~ current methodology to use a Wavelet iterated filter

25   bank construction to ~~obtain~~ generate ~~the~~a Wavelet, and ~~the~~to apply —current methodology to generate ~~the~~a Wavelet as a function of the scaling functions, and —~~that provide a means~~ ~~for~~said implementation provides flexibility to meet ~~the~~ application goals;

30   using ~~provide a means for the design of~~new orthogonal OWDMA filters and filter banks ~~using~~ implemented with multi-resolution complex Wavelet channelization waveforms ~~designed~~ generated in the Fourier domain, and which can include analytical and iterated filter bank construction design techniques;

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using implementations ~~provide a means~~ for ~~the design of new~~ orthogonal OWDMA filters and filter banks over contiguous and non-contiguous frequency bands, ~~and~~ for simultaneous multi-resolution OWDMA filters at different scales and different frequencies and different symbol rates, ~~and~~ said implementations using multi-resolution complex Wavelet channelization waveforms ~~designed~~ generated in the Fourier frequency domain and which can include analytical and iterated filter bank construction ~~design~~ techniques;

~~provide~~ using a ~~means for the design of the~~ mother multi-resolution ~~Wavelet~~ at dc ~~in~~ the Fourier frequency domain ~~and a means for~~ constructing ~~the~~ a desired multi-resolution complex Wavelet from ~~this~~ said mother Wavelet using appropriate scale, frequency, and translation changes to the mother Wavelet; and

implementing said OWDMA filters in a communications transmitter and in a communications receiver for a communications link.

Claim 2. (currently amended) A ~~means~~ method for ~~the design~~ implementation of new multi-scale complex code division multiple access MS-CDMA ~~encoding~~ and decoding over multiple scales where each scale corresponds to an independent communications parameter, ~~and~~ which MS-CDMA encoding includes the complex pseudo-noise spreading or covering, and which MS-CDMA decoding includes removal of this complex pseudo-random spreading or covering, said method comprising: ~~and which~~

using ~~provide a means for~~ complex orthogonal MS-CDMA encoding spreading over a frequency band with a lower chip rate than the chip rate using current CDMA encoding;

using ~~provide a means for~~ complex orthogonal MS-CDMA encoding spreading over a non-contiguous frequency band ~~with a~~ lower chip rate than the chip rate using current CDMA encoding;

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~~provide~~ using ~~a means for controlling the~~ power level ~~of~~ control of the transmitted signal as a function of the frequency over the frequency band;

_____ ————using ~~provide a means to implement the~~ fast complex

5   MS-CDMA encoding —and decoding over multiple scales, and which MS-CDMA —includes the complex pseudo-noise spreading or covering and the removal of the complex pseudo-random spreading or covering;

~~provide a means to~~ partitioning the frequency band into

10   independent subbands or groups of subbands and ~~to~~ MS-CDMA ~~encode~~ encoding and spreading the users over these subbands or groups of subbands;

~~provide a means to~~ partitioning the frequency band into independent subbands or groups of subbands, ~~and~~ assigning ~~the~~

15   users to the subbands or groups of subbands, and ~~to~~ MS-CDMA ~~encode~~ encoding and spreading the users within their assigned subbands or groups of subbands;

~~———— provide a means to implement a 2 scale MS-CDMA to assign~~
~~the users to subband groups and to MS-CDMA encode and spread each~~

20   ~~set of users in these groups such that each user in the group is~~
~~spread over all of the subbands in the group in a scale 1~~
~~encoding and spreading and is spread within each subband of the~~
~~group in a scale 0 encoding and spreading and provide a means for~~
~~implementing fast encoding and decoding algorithms~~

25   implementing ~~provide a means a means to implement~~ a 2 scale MS-CDMA ~~to assign~~ and assigning the subbands over a frequency band into MS-CDMA groups, ~~and to~~ MS-CDMA ~~encode~~ encoding and spreading each user in ~~a~~ each group such that each user is spread within each subband in the MS-CDMA group in a scale "0" encoding and

30   spreading, —each user in each group~~and~~ is spread over the subbands of the MS-CDMA group in a scale "1" encoding, and spreading and ~~provide a means for~~ implementing fast encoding and decoding algorithms;

using a ~~provide a means to exploit the separability of~~

35   ~~the~~Kronecker product (tensor product) for generating a —complex

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orthogonal 2--scale MS-CDMA code matrix as a ~~generalized~~
Kronecker product of a subband complex orthogonal MS-CDMA code
matrix for scale "0" encoding and spreading and a wideband
complex orthogonal MS-CDMA code matrix for scale "1" encoding and
5   spreading, —and ~~provide a means for~~ implementing fast encoding
and decoding algorithms,

using ~~provide a means to exploit the separability of the~~
~~complex orthogonal multi-scale MS-CDMA code matrix as generalized~~
~~Kronecker products of~~ Kronecker product (tensor product) for
10   generating a complex orthogonal N-scale MS-CDMA code matrix as a
Kronecker product of orthogonal complex MS-CDMA code matrixes for
each of the MS-CDMA scales "0", "1", . . . ~~.~~, "N-1", ~~and~~ with
each scale assigned to an independent communications parameter,
~~and~~ with each scale performing encoding and spreading of the
15   users, and ~~to provide a means for~~ implementing fast encoding and
decoding algorithms,

using an algebraic field factorization and scaling to
convert a CDMA code matrix to a 2-scale CDMA code matris by

generating a CDMA code with a code length equal to a
20   product of a number of chips for a first scale "0" CDMA
encoding having first code and chip indices used to encode
data symbols within each subband, and a number of chips for
a second scale "1" CDMA encoding having second code and
chip indices used to encode data symbols over the entire
25   set of subbands,

forming a 2-scale CDMA code by assigning code and chip
indices such that the 2-scale CDMA code and chip indices
are the algebraic addition of the first sca;e "0" code and
chip indices plus scaled second scale "1" code and chip
30   indices, wherein said scaled indices are generated using a
scale factor that comprises the number of indices in the
first scale CDMA code,

wherein the steps of generating and forming further
include encoding data symbols with the 2-scale CDMA code to
35   generate encoded chips,

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assigning each of the encoded chips to a subband in accordance with the second scale "1" CDMA code indices, assigning each encoded chip to a chip position within its assigned subband in accordance with the first scale "0"

5   CDMA code indices, and encoding with pseudo-noise covering, and generalizing said implementation to scales "0", "1", . . , "N-1" for an N-scale MS-CDMA code matrix ~~provide a means for generating a complex orthogonal multi-scale MS-CDMA code matrix which exhibits the separability property that allows the~~

10   ~~MS-CDMA code matrix to be separable into a generalized outer product of 2 or more complex orthogonal MS-CDMA code matrices for encoding spreading at each of the scales and~~ with each scale assigned to an independent communications parameter, ~~and~~ with each scale performing encoding and spreading of the users, and ~~to~~

15   ~~provide a means for~~ implementing fast encoding and decoding algorithms; and

implementing said N-scale MS-CDMA in a communications transmitter and in a communications receiver for a communications link.

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Claim 3. (currently amended) A ~~means~~ method for ~~the design of~~ implementing new multi-scale complex code division multiple access MS-CDMA —orthogonal frequency division multiple access

25   OFDMA communications, ~~and a means~~ for ~~the design of~~ implementing new —MS-CDMA orthogonal Wavelet division multiple access OWDMA communications, ~~and~~ which MS-CDMA encoding includes ~~the~~ pseudo-noise complex spreading or covering, and which MS-CDMA decoding includes removal of this pseudo-random complex covering or

30   spreading, ~~and which~~ said method comprising:

using ~~provide a means for~~ MS-CDMA encoding and spreading of ~~the~~ users over ~~the~~ OFDMA or OWDMA channels in a frequency band which may be non-contiguous;

using ~~provide a means for~~ MS-CDMA encoding and spreading of ~~the~~ users in ~~the~~ OFDMA or OWDMA channels over a frequency band which may be non-contiguous;

using ~~provides a means for~~ MS-CDMA encoding and spreading
5   of the users within each ~~of the~~ OFDMA or OWDMA channel~~s~~ and over all of ~~the~~ OFDMA or OWDMA channels such that each user is in each ~~of the~~ OFDMA or OWDMA channel;

~~provide a means for~~ implementing fast encoding and decoding algorithms for ~~the~~ complex MS-CDMA;

10   ~~provide a means for~~ implementing fast algorithms for ~~the~~ a multi-resolution complex Wavelet transform for OWDMA encoding and ~~a means for~~ implementing fast algorithms for ~~the~~ multi-resolution complex Wavelet transforms for OWDMA decoding;

using ~~provide a means to implement~~ a 2 scale MS-CDMA OFDMA
15   or MS-CDMA OWDMA ~~to~~ assigning ~~the~~ users to channel groups and ~~to~~ MS-CDMA ~~encode~~ encoding and spreading each set of users in these groups, such that each user in ~~the~~ a group is spread over all of the channels in ~~the~~ a group in a scale "1" encoding and spreading, and is spread within each channel of ~~the~~ a group in a
20   scale "0" encoding and spreading, and ~~provide a means for~~ implementing fast encoding and decoding algorithms;

using a Kronecker product for constructing ~~provide a means for generating~~ a complex orthogonal multi-scale MS-CDMA code matrix ~~which exhibits the separability property that allows the~~
25   ~~MS-CDMA code matrix to be separable into a generalized outer product of 2 or more complex orthogonal MS-CDMA code matrices~~ for encoding spreading at each of the scales, ~~and~~ with each scale assigned to an independent communications parameter, ~~and~~ with each scale performing encoding and spreading of the users, and
30   with one or more scales assigned to OFDMA or OWDNA;

using an algebraic field factorization and scaling for constructing a complex orthogonal multi-scale MS-CDMA code matrix for encoding spreading at each of the scales, with each scale assigned to an independent communications parameter, with each

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scale performing encoding and spreading of the users, and with
one or more scales assigned to OFDMA or OWDNA; and

       implementing said MS-CDMA OFDMA and MS-CDMA OWDMA filters
in a communications transmitter and in a communications receiver
5   for a communications link.